# LuxMeter Pro Advanced

DIGITAL LUX METER

## MANUALE UTENTE

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Ver.1.0.0

# 1. INTRODUCTION

LuxMeter Pro is an Advanced application for iPhone and iPad, which uses the internal camera to calculate, in real time, the level of illumination of the image captured by the camera. It should be noted that the camera does not work like the brightness sensors used in traditional light meters which measure the level of incident light, but in this case LuxMeter Pro measure the light reflected from the objects present in the area shown by the camera. This substantial difference makes the use of this application totally different from classic light meters, and it is also not possible to perform the measurement of light emitted directly from the light source. Pointing the camera at a lamp directly, this would be dazzled it by providing an image not be used for the calculation of lighting.

There is also another very important factor which implies the proper functioning of LuxMeter Pro Advanced, that is to use a white target areas where black or prevails particularly dark tones are present into environments. In the case of dark or black objects or areas with a predominance of dark object, you must enter a target blank object because black objects do not reflect light preventing LuxMeter Pro to be able to analyze the lighting intensity. The white target could be any white object that occupies 30% minimum of the illuminated area, in areas with objects of various shades LuxMeter Pro automatically calculates the value of medium gray and its lighting without the need to target white.

# 2. HOW DOES LUX METER PRO WORK (Measure Process)

LuxMeter Pro Advanced, being an application and not a specific device, in order to ensure a reasonable accuracy in measurements, requires some precautions. The first thing to do before the measurement is to correctly set the parameters for the type of lighting, so as to make it possible for the correct setting LuxMeter Pro of the gain of the camera and the parameters of calculation of luminous intensity. Considered that light follows a series of physical phenomena to which attention must be paid.

Required parameters are:

- Type of light source.
- Source distance from the illuminated area.
- lighting Cone Viewing angle (in the case of headlamps or LED lights), or 180°.
- Wattage of the light source.

The parameters above are usually available on light sources except for the distance from the area to be measured or estimated to be trying to get as close as possible to the real one. It should be kept in mind that the light intensity attenuation increases with a value equal to the square of the distance, this means that even a few inches of difference can result in large decreases in the level of illumination.

This phenomenon can be seen by observing the effect of a lamp placed at different distances from an object, we realize immediately that as well as the lamp the same power and then the same luminous intensity, this illuminate with different intensities depending on the distance from which the object is located.
The type of lighting is available from the source used, which can be of various kinds, for example, an **incandescent lamp**, a **fluorescent tube**l, **LED** etc. the type of lamp is indispensable in order to ascend LuxMeter Pro lighting efficiency is the value of transformation from Watts to LUMENS which differs from type to type based on lamp technology.
It is understood at this point, that the value in Watts is required to determine the value of the lamp LIGHT or group of lights used.
The lighting angle is the angle of the cone generated by the projector used by the source, this value is present in lamps which focus the beam of light in one direction, type lamps (PAR), LED lamps and all the lights that have a worm or a reflective screen, in other cases where the source illuminates the surrounding area in all directions is regarded as illumination angle an angle of 180°.

## 3. LIGHT SOURCE (Light Type)

We see in detail the types of sources used in LuxMeter Pro Advanced:

**Incandescent lamp:**
Common lamp filament with power ranging between 5 and 500 Watt with color temperature about 2400K.
Light source with low yield n = 15

**Incandescent lamp: halide**
Filament lamp with power ranging between 15 and 1500 Watts with about 2600 k color temperature.
Light source with low yield n = 20

**Hot-cathode fluorescent tube:**
the fluorescent tubes have a power ranging between 18 and 65 Watt bulb with a color temperature which varies between 2700 and 4500 K.
Light source with decent yields n = 60

**LED Light:**
Led lamps provide capacities between 10 and 70 Watts
With a color temperature of approximately 6200 k
Discrete performance light source n = 60

**Quartz light:**

Quartz lamps provide between 90 and power 450 Watt
With a color temperature ranging from 4500 to 6500 k
Light source with Good yield n = 87

**Light high pressure sodium:**
Sodium lamps provide powers between 250 and 800 Watts
With a color temperature that ranges from 30000 to which
Light source with high yield n = 117

**Light to low-pressure sodium:**
Sodium lamps provide powers between 250 and 800 Watts
With a color temperature that ranges from 30000 to which
Light source with high yield n = 150

**Sunlight**:
Sunlight provides an intensity of light varies depending on weather conditions with values that correspond to the following table:

- Cloudy: 10 ' 000 lumens
- Daylight in shade 25 ' 000 lumens
- Direct daylight 32 ' 000 lumens
- Direct sunlight 130 ' 000 lumens

## 4. DISTANCE TO THE LIGHT SOURCE (Source Distance)

The distance of the light source from the illuminated area is important for the correct measurement of lighting, let's see what are the conditions of proper measuring and how it should be set in order to work Pro LuxMeter optimally.

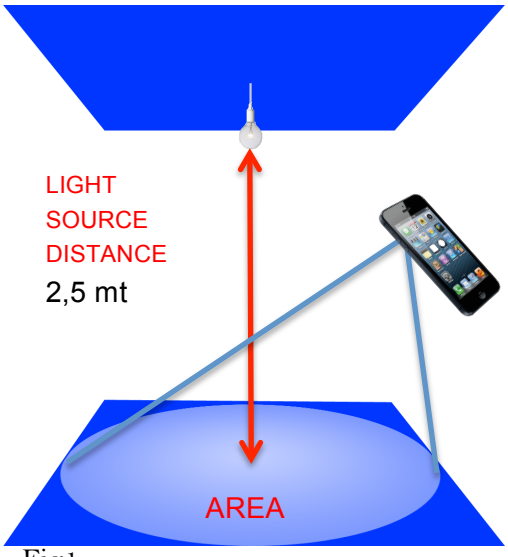


Fig1

Figure shows a simplified diagram of a possible condition, as you can see the iPhone is pointed toward the illuminated area and not to the light, in this case the distance to set parameters LuxMeter Pro is the minimum distance from the source to the surface or illuminated object, the image is marked by the red arrow.

Fig2

The distance of the light source, it must be set in the LuxMeter Pro main screen by moving the Slider "Distance mt" or by entering the value manually by tapping the icon that depicts a hand next to the slider, thus enabling the input mask manually.

## 5. TAPER ANGLE OF ILLUMINATION (Viewing Angle)

Normally the light sources, particularly as except in LEDs, light is radiated into surrounding space at the source. Usually the light sources are placed on walls or attics and under these circumstances, a portion of the light is obscured from the wall where the lamp is placed, that is why the lights that do not have a reflective screen or a projector must be set with the value of the lighting angle 180°

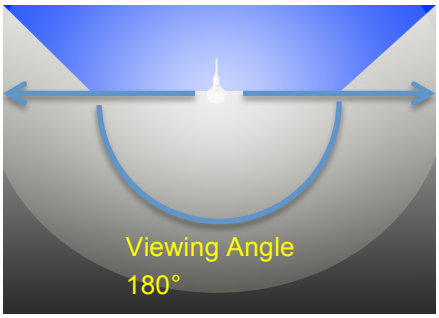



Fig3

The lamps without reflector and projector are without illumination angle "Viewing Angle 180°"

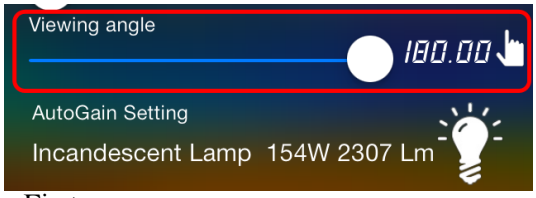



Fig4

The parameter Viewing Angle must be set in the settings panel of the LuxMeter Pro using the Slider or by entering manually the value.

In order to get a better yield of light is possible through a screen reflecting or parabolic projectors, convey the light produced from the source in one direction, creating a cone of light that will illuminate the area or object concerned. Based on the structural characteristics of the shroud the light cone can have different lighting angles as shown in Figure 5

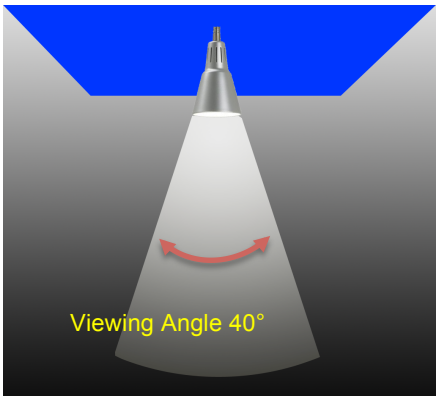



Fig5

In this configuration, all the light is conveyed in one direction, thereby improving the ability to source lighting low power used.

As for the previous example, the lighting angle value must be set in the settings panel of the LuxMeter Pro using the Slider or by entering manually the value of the angle.

## 6. SOURCE POWER EXPRESSED IN WATTS (Power Light)

The value in Watts of power of the light source is used by LuxMeter Pro to calculate the equivalent Lumen brightness, depending on the type of lamp used and its coefficient of lighting $\eta$.

The value in the lumen of the source or/and of the sources is given by the product of total power in Watts x $\eta$.

For example, if in an environment there is only one light source, simply locate its power, usually found printed on the lamp itself, and enter the value in Lux Meter Pro Advanced.

Some examples of visible Power on lamps:

25Watt halogen lamp

Halogen lamp with integrated projector from 75 Watt

18 Watt fluorescent tube

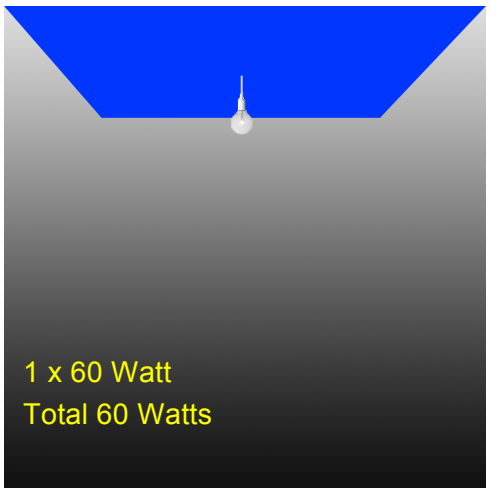



Fig 6

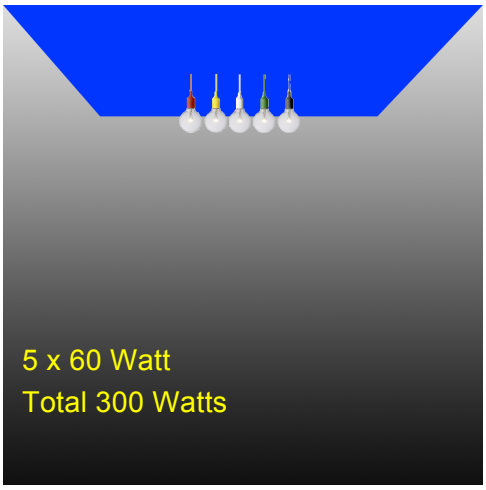



Fig 7

In case there are multiple environment lamps, the value to set in the LuxMeter Pro will be the sum of all lamps are turned on simultaneously.

# 7. MAIN MENU

Fig 8

After giving a look at essential data to operate, now analyze main menu structure and functions contained therein.

Let's start with the most important elements:

**Lux Value 1)** – returns the maximum value of the illumination measured by the camera, the value is expressed in Lux (lumen/$m^2$).

**2) Preview** – preview shows the processed image from LuxMeter Pro, and you can select the display mode between "normal" that shows the captured image without elaboration, "CScale" that displays the image in a variety of colors depending on the light intensity present in that particular part of the image; the color scale goes from dark blue – red brightness detected minimum – maximum brightness.

"GScale" that consists in the view of the processed image in grayscale, as for CScale mode, in this mode the minimum Intensity is Black and white the highest.

**3) colour temperature Viewer** -LuxMeter Pro calculates the color temperature of the captured image, not to be confused with the color temperature of the light source. The color temperature calculated from LuxMeter Pro is that derived from the dominant media present in the image, in a nutshell LuxMeter Pro analyzes the colors present and find the white point of the image using the reference table "CIE D65" with white point set at 6504K. The value then does not express white light used to illuminate the object but the result depends on the composition of the colors in the object illuminated.

This means that the calculated value may fluctuate depending on the dominant in the area affected by the measure. For example, if the image contains only one color LuxMeter Pro in color space conversion from RGB to YXZ fails to achieve the correct white point value, because the colors in the image does not have the coordinates need to be able to calculate this value. In this case we will return a LuxMeter Pro temperature value which is the dominant color, which might be close to 2000 k for images with a predominance of red, or which tends to 8000 k for those with a prevalence of blue. In order to obtain a correct temperature you can put inside the frame a white object, such as a sheet of paper or do enter into the frame other items of different colors in a way that LuxMeter Pro to calculate the correct coordinates of the color components in the image.

Fig9

Fig 10

In the color temperature value, in addition to the numeric value is also a chart with the histogram of the distribution of the components of whiteness. On the left side of the chart are the shades that converge towards the red component of the "warm" light.

If you have a high concentration of hue in this fraction of the chart means that converge toward temperature values from 2000 to 4000 k, the central part namely related to white, as we mentioned earlier takes temperature values around 6500 k (CEI D65) and therefore the right of the graph shows the concentration of the components that go into the blue with temperatures up to 10000 k.

4) **Control Panel** – In Control Panel contains buttons that allow access to some functions of LuxMeter Pro. In order we have the following functions:

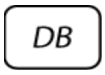
Upload from photo library – allows you to analyze a picture in the library.

Return to LIVE mode with the use of the camera.

Temporarily freezes the screen, leaving the last value, when it is active in the display appears the symbol HOLD.

Enables and disables the camera's white balance, this function is useful if the area to be analyzed has dominant colors that may affect the calculation of colour temperature. When the function and activate icon appears in the display AWB.

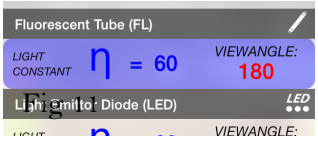
The SAVE Function lets you save the current measurement with all its values.



DB button opens the list of saved measurements see paragraph 11.

Change the camera used by the back to the front and vice versa.

Open the form of the type of setting the lamp used in the measure, to select the just touch a lamp by sliding fig. 11 checklist



Fig

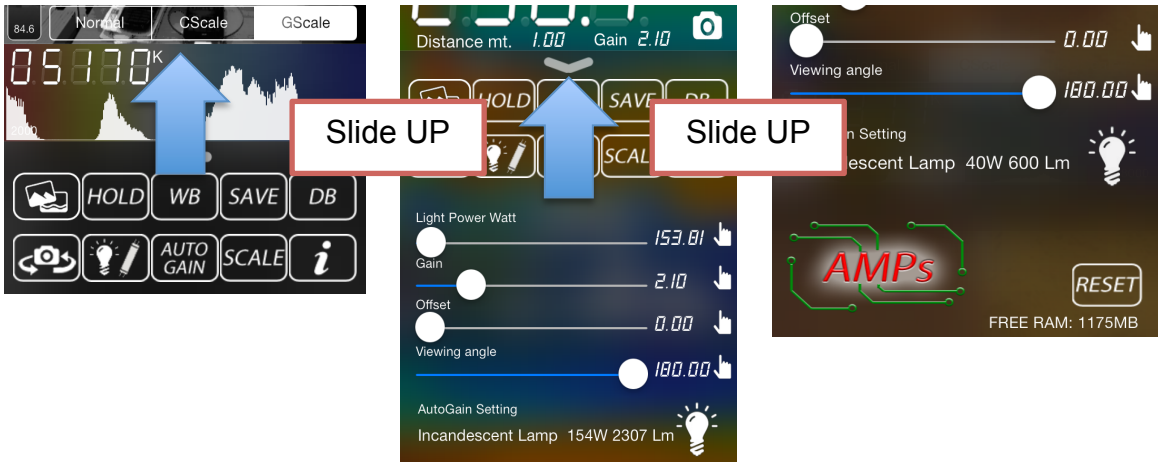
The new AutoGain function is useful when the camera gain setting is incorrect, the Auto Gain calculates the correct value of Gain using as reference a lamp with known characteristics, see section 12.

The SCALE function changes the underlying value scale by multiplying x 1, x 10, x 100 and x 1000 scale of measurable values, see paragraph 14

This button opens the LuxMeter information Mask Pro Advanced.

## 8. SETTING SLIDING PANEL (Slide up Settings Panel)

Running with his finger upwards starting from the buttons Panel, displays the settings panel. In this Panel you can set the parameters of the light source as the lamp power in Watts and the illumination angle in degrees, and the parameters of the camera Gain (Gain and Offset).




Queued the sliding panel is displayed in addition to the type of filament lamp chosen, the amount of free memory on your device and the reset button to reset all Default values

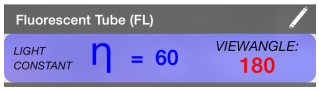
## 9. HOW TO MAKE A MEASURE (Measure Process)

Let's see how you can use LuxMeter Pro to make a measure of illumination of an environment. Consider a closed environment, such as an Office lit with fluorescent tubes mounted on the ceiling, as shown in the figure below.

We want to assess the overall lighting of the Office, i.e. all 4 lamps that illuminate the entire space below, the first thing to do is select the type of lighting used, in this case the **FLUORESCENT TUBE** .

- Press the selection button of the typology of lamps

- Select the type "**fluorescent tube**"



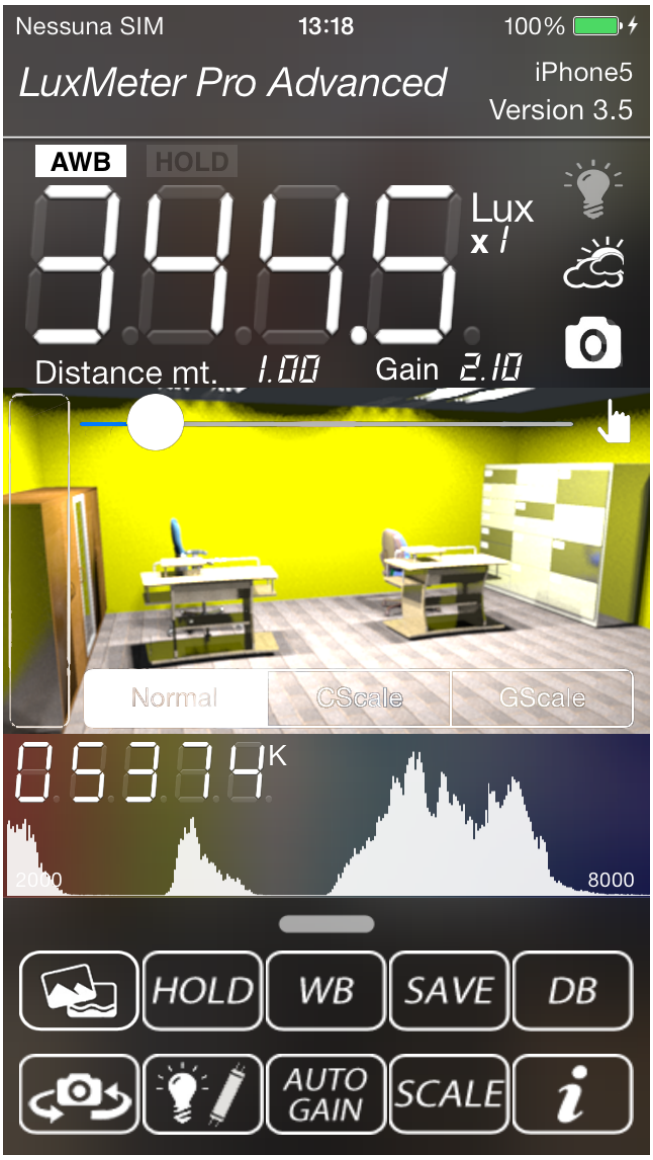

As a standard value the fluorescent tube has a illumination angle of 180° which can be modified, if necessary, through the appropriate slider "Viewing Angle".

The next thing is that you set the power of the lights installed in our

Here are 4 lamps each one with 2 fluorescent tubes from 45W, so we [45 W x 8 = 360 pipes] Watt installed. This value must be set with the slider marked "Light Power Watt" sliding panel.

The last phase of Setup is to set the distance of the light source from the illuminated area. In this case, knowing the ceiling height which is 2.5 meters above the average value between the sources and the area below may be approximated to 2.05-2.10 m. This value

is inserted in the main form of LuxMeter Pro via the slider ", Distance mt".
At this point it is sufficient to point the camera of the iPhone/iPad to the area to measure trying to display within the preview pane, the affected area as seen in the example image, we should have a situation as shown in the example below:




If all parameters are correct and the Gain of the camera is set correctly, the display will show the value of consideration of overall lighting in Lux. Of course if you move the camera to a different zone, we'll have to reconfigure the parameters that have been changed such as the power of the lights and/or the distance of the source.
In case the lighting parameters are correct and the value calculated from LuxMeter Pro is not plausible, you may need to recalibrate the camera's Gain. The calibration procedure is described in section 12 "Auto Gain".

## 10. PREVIEW MODE (Preview Mode)

In order to get a detailed view of the detected light intensity in the various area affected by observation, you can enable in addition to standard mode, as mentioned at the beginning of this document, other two modes, called CScale "Color Scale" and another GScale "Gray Scale". Specifically the CScale mode, reprocess the image captured by the camera by replacing with different shades of color areas with different light intensity. Areas with less brightness will appear in blue and Red will be brighter. Here is a demo that shows how image LuxMeter Pro discriminates against various areas with different light intensity.

As you can see in the image to the left, LuxMeter Pro view preview screen even a scale of colors with brightness values, the values refer to the minimum and maximum value measured in the image captured by the camera. But we must pay attention to a particular condition, in this example you can see an image where the walls and ceiling are white while on a wall there is a door that LuxMeter Pro depicts with color "proffer". Anyone following the previous reasoning and referring to the scale of colors visible on the left, might think that the area affected by the door has a lower luminous intensity despite being in the area of the wall where the intensity is higher, as is visible from the surrounding red. In fact even if the target is illuminated with the same intensity in the area environment is considered darker than for the simple fact that is Brown and compared to wall white, reflects much less light, tricking so LuxMeter Pro. In cases like this it's always best to make a comparison with the captured image into normal mode and exclude from scans all areas which have a much darker colour than the rest which could mislead the Viewer.

Compare the pictures capture in three different ways in order to understand how LuxMeter Pro interprets the data collected by the camera.

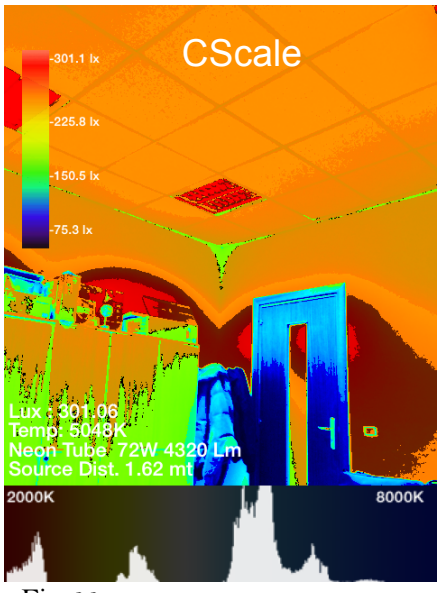



Fig 22

Fig 23

Fig 24

Comparison of three images can be seen as LuxMeter Pro highlights areas with different light intensity as CScale mode in GScale dark colors can I fool the process giving a result that is not trusted, as seen in Fig23, where the target appears black, although located in the zone of maximum exposure.

## 11.SAVE MEASUREMENTS ND DB SAVES (Save Measure / DB)

During a measurement, you can save all acquired data, including color temperature chart and preview mode. The rescue work is enabled by the SAVE button and generates an image file with all acquired data. You must enter a name for the Save and the data will be stored in the application folder in "Documents/SaveData" accessible from iTunes when you connect the device to your Mac/PC.

It is always possible to access saved measurements and using the "DB" button. The DB form presents a list of all saved measurement as shown in Fig. 25, in the list of saved measurements are visible measurement data is a miniature of the captured image. From this form you can view the measure with all of its data, or send it via email by entering as an attachment to the saved image. An example is shown in Figure 26.

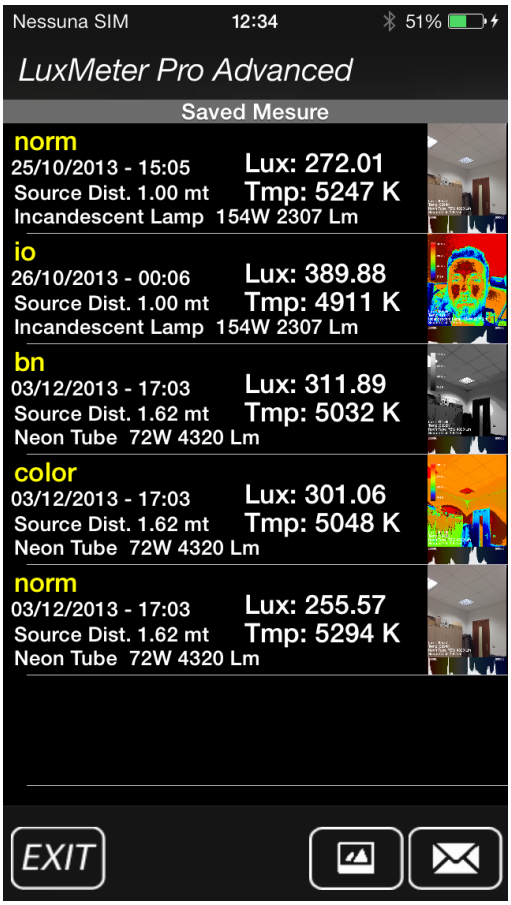


Fig 25

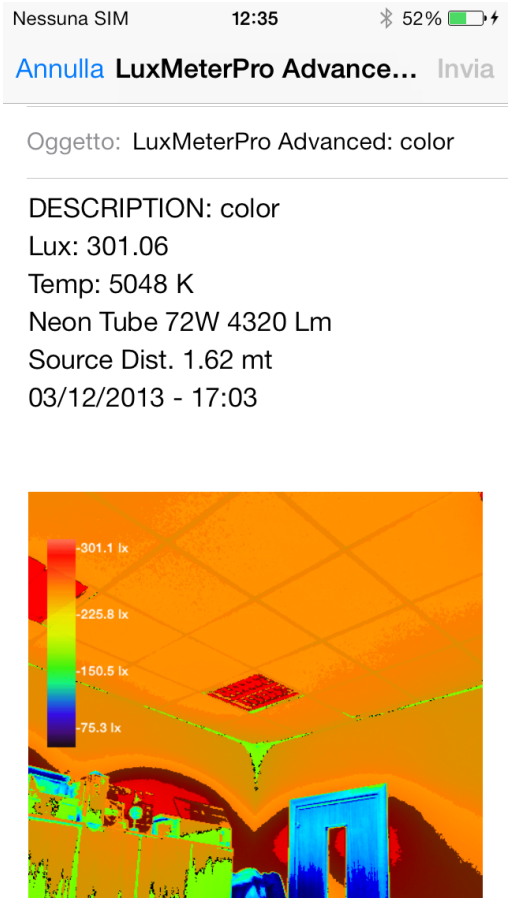


Fig 26

## 12. AUTOGAIN CAMERA CALIBRATION (Camera AutoGain)

It may be necessary to recalibrate the camera gain of iDevice to achieve greater accuracy in the measurement of light. This adjustment can be made manually by editing the value of the Gain slider via the "Gain" in the settings panel.

The value can also be changed by inserting
The value via the keypad button enabled
depicting the hand.
The "Auto Gain" is activated with the button placed on the main screen buttons Panel.

The new AutoGain function requires the use of a light source with known characteristics and a blank sheet of paper. The calibration procedure is to set correctly the parameters of the light source and tap the button "AUTO GAIN" button to start the calibration process, focusing the camera on white sheet illuminated by the light source. In Figure 27 is an example of possible camera calibration using a desk lamp by mail 15Watt at a distance of 60 cm from the paper.

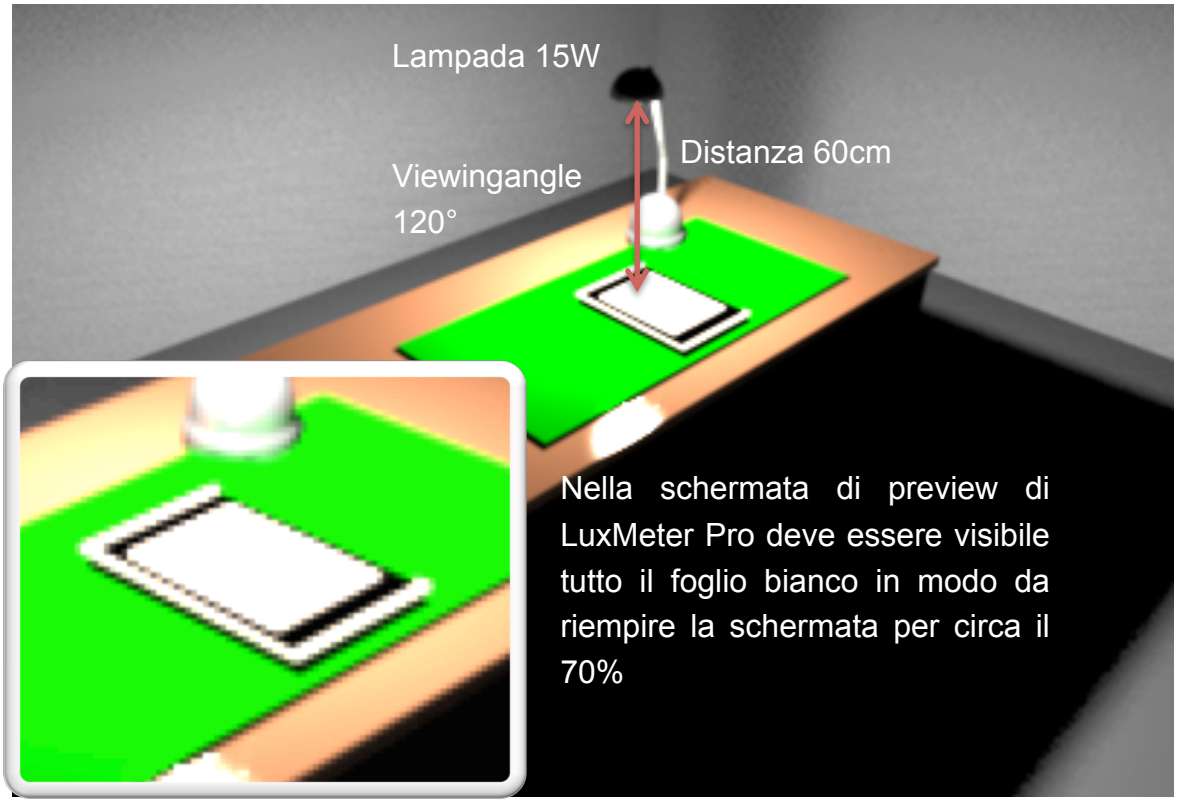



Fig 27

## 13. CALIBRATION WHIT COMPARISON TOOL (LuxMeter Compare)

If necessary make a manual calibration by comparison with a sample LuxMeter, the procedure is similar to that of only the new autogain value of gain should be set to manual until you get the same value provided by comparison tool. Specifically the comparison tool sensor should be positioned on the white sheet or adjacent to it so as to be illuminated in the same way as the paper itself, and the value that appears to be the same that we get from LuxMeter Pro by modifying the Gain value as shown in Figure 28

Fig 28

## 14. SCALE SETTING (Scale)

Depending on the type of measurement to be made you can change the full scale value of the display using the "SCALE" button on the main screen buttons Panel. The Scale button changes the scale factor between 4 options:

x 1 maximum 999.9 Lux
x 10 maximum 9999 Lux
x 100 maximum 99999 Lux
x 1000 maximum 999999 Lux

In the case of off the charts on the display you will see the following value "----" flashes
fig 29

Out Of Scale

Fig 29

15. NOTE